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ABSTRACT

This publication presents the results of a survey of biology teaching in secondary schools during the 1965-66 academic year. The study, conducted by the Educational Testing Service, involved a sample consisting of approximately 38,000 students who took the College Board achievement tests. The results were tabulated for the Biological Sciences Curriculum Study (BSCS) and non-BSCS students separately. Data revealed that biology students wishing to enter college took courses in chemistry and physics. There appeared to be considerable emphasis on molecular and cellular topics in biology courses. Laboratory experiences appeared to have changed considerably from the conventional dissection approach. Two or more hours of laboratory work per week were assigned in most schools. A large percentage of students took a second course labeled Advanced Biology. Tables of statistical data are provided. Description of design, questionnaires and administration details are included in the appendix. (PS)

TEST DEVELOPMENT REPORT
TDR-69-6 MAY 1969

A Survey of the Teaching of Biology in Secondary Schools

William Kastrinos
Test Development Division, ETS

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Preface

Probably more changes have occurred in secondary school curriculums during the past ten years than in any previous decade in our nation' s history. The impact of these changes on the academic preparation of college-bound students is of concern to the College Entrance Examination Board, which prepares achievement tests for college admissions programs. To obtain factual information on what individuals actually study in secondary school, the College Entrance Examination Board supported a survey of about 38,000 students who took College Board achievement tests during the 1965-66 academic year. These students represented more than 7,500 secondary schools throughout the United States.

Before the survey was initiated, the question of whether or not students both could and would give valid accounts of their educational experiences was investigated. The results of this feasibility study, which was conducted in about 50 high schools for seniors studying French and chemistry, showed a satisfactorily high agreement between teachers' and students' responses to the same questions. As might be expected, agreement was highest in the most recent grades. However, even as far back as grade 9, there was a mean student-teacher agreement of 70%. In the case of highly factual questions, percentages ranged from 90 to 100%. Interviews carried on in a selected sample of these 50 schools showed that student responses to questions that they understood were valid even in the case of recall over three and four years.

At the onset, these data were to be used only for developing better achievement tests. However, as the study progressed, their potential usefulness to a wider audience of educators became more apparent. The fact that College Board achievement tests are taken by only a fraction of college entrants is an inherent limitation in the use of these data. However, extensive information such as that collected for this study is highly relevant to many current issues in secondary education.

Consequently, Educational Testing Service is publishing these results in a series of eight reports, one in each of the following subjects: English, history, biology, chemistry, physics, mathematics, Latin, and modern foreign languages (French, German, and Spanish). The author of each of these reports is an examiner in the subject field in the Test Development Division of Educational Testing Service. Special consultants assisted these authors in identifying the findings in each field that would be of the greatest importance and interest to the educational community. Details of the study design and administration appear in Appendix A.

Elizabeth W. Haven
Project Director

Acknowledgments

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Professor Burton Voss, University of Michigan, who, in his capacity as consultant, made many helpful suggestions regarding the organization of the report and who also reviewed draft copy of the report.

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Mrs. Winifred Procter who performed editorial reviews and offered a number of suggestions for stylistic improvements.

Mrs. Dorothea S. Fisher who performed the final editorial review.

Miss E. Elizabeth Stewart and Mr. Miles McPeek who reviewed the final draft and made many valuable changes and suggestions to improve the report.

Introduction

Within recent years there has been extensive revision of secondary school courses in biology. The American Institute of Biological Sciences established the Biological Sciences Curriculum Study (BSCS) group in 1959 and charged this group with preparing materials that would contribute to the improvement of biological education at the secondary school level. In 1960 a group of 70 secondary school biology teachers and college biologists met and started to prepare the material. The writers decided that there should be different approaches to the first-year course and consequently three versions were developed. The three versions were called BSCS Blue Version, BSCS Green Version, and BSCS Yellow Version; they will be referred to as such throughout this report. The texts were first printed in paperback and revised each summer over a period of three years. In 1963 the textbooks were retitled and published commercially (1, 2, 3).

The questionnaire data on which this report is based provide information about the organization, content emphasis, and laboratory emphasis of secondary school courses in biology, both those using BSCS texts and those using other texts. Some of the major concerns included the topics studied by the students, the type of laboratory work engaged in, and the organization of the biology courses. Because the survey of preparation in biology was restricted to students who had taken the College Board Achievement Test in that subject, the results cannot be considered descriptive of a typical group of secondary school students who studied biology during the period covered by the survey. Subject to this important limitation, however, the survey data indicate the extent to which various curricular innovations have been reflected in the courses offered in secondary schools in recent years.

Population of the Biology Study

The biology study of the College Board Survey was based on a sample of 1554 seniors who took the College Board Biology Test in December 1965, January or March 1966, and 598 juniors who took the test in May 1966.

Two separate statistical analyses were made of the entire sample so that the senior group could be examined apart from the junior group. Additional separate analyses were made of the juniors and seniors who had taken only a first-year course in biology. Summaries of the numbers of students included in the various analyses appear in Tables 1 and 2, in which the students have been classified by school (Public, Roman Catholic, Independent), location of school (Northeast, South, Midwest, West), and the nature of their course (BSCS versions or non-BSCS). In order that data for students who had been tested in March would not contribute disproportionately to the total, a weighting procedure was followed. In Table 1 both unweighted and weighted totals are shown for seniors combined across test administrations. The unweighted totals represent the actual numbers of individuals from whom usable questionnaires were received. The weighted totals were derived by multiplying the number of such individuals who had been tested in December or January by 1.9 and adding to the product the number of individuals who had been tested in March. Weighted frequencies were used to develop all percentages cited in this report.

TABLE 1

Number of Seniors in Total Sample and in Subsample of Students Who Had Taken Only a First-Year Course in Biology, Classified by Date of Test Administration, Type of Support, Geographical Location of Secondary School, and First-Year Biology Curriculum

	Number of Seniors in Total Sample				Number of Seniors in Subsample			
	Admin. Date		Total		Admin. Date		Total	
Classification	Dec.—Jan.	Mar.	Unwted.	Wted.*	Dec.—Jan.	Mar.	Unwted.	Wted.*
Type of School								
Public	1,003	264	1,267	2,170	584	144	728	1,254
Roman Catholic	174	68	242	399	135	56	191	312
Independent	37	8	45	78	20	4	24	42
Location of School								
Northeast	665	142	807	1,405	424	89	513	895
South	113	26	139	241	58	17	75	127
Midwest	252	112	364	591	158	72	230	372
West	184	60	244	410	99	26	125	214
Biology Curriculum								
Non-BSCS	1,065	294	1,359	2,318	641	179	820	1,397
BSCS Blue	51	13	64	110	32	7	39	68
BSCS Yellow	58	24	82	134	37	14	51	84
BSCS Green	40	9	49	85	29	4	33	59
Total BSCS	149	46	195	329	98	25	123	211
Total	1,214	340	1,554	2,647	739	204	943	1,608

*Seniors tested in December or January have been given a weight of 1.9 and seniors tested in March, a weight of 1.0.

TABLE 2

Number of Juniors in Total Sample and in Subsample of Students Who Had Taken Only a First-Year Course in Biology, Classified by Type of Support, Geographical Location of Secondary School, and First-Year Biology Curriculum

Classification	Number of Juniors in Total Sample	Number of Juniors in Subsample
Type of School		
Public	410	333
Roman Catholic	90	86
Independent	98	84
Location of School		
Northeast	477	410
South	54	43
Midwest	37	27
West	30	23
Biology Curriculum		
Non-BSCS	440	371
BSCS Blue	41	32
BSCS Yellow	82	76
BSCS Green	35	24
Total BSCS	158	132
Total	598	503

Biology Candidates' Background of Science Courses

Tables 3 and 4 summarize the candidates' reports of the science courses they had taken and the grades that they were in at the time.

Note in the second line of Tables 3 and 4 that 24 per cent of the juniors taking the test were taking the first-year biology course during their junior year whereas only 7 per cent of the seniors took biology as a first-year course in the junior year. Of the seniors 62 per cent took biology in their sophomore year whereas only 48 per cent of the juniors took biology in their sophomore year.

Tables 3 and 4 also indicate that the percentage of these College Board biology candidates who took courses in chemistry and physics is considerably higher than is normally found in a cross section of secondary school juniors and seniors: 73 per cent of the seniors had taken or were taking a course in chemistry and 40 per cent had taken or were taking a course in physics. The juniors show a pattern similar to that followed by the seniors in the sophomore and junior years, although a somewhat smaller percentage of juniors (42 per cent) than of seniors (55 per cent) reported taking a course in chemistry prior to the senior year.

TABLE 3

Percentages of Seniors Who Reported Taking Selected Science Courses, Grades 9-12, by Semester

(Based on all seniors*)

Course	Grade 9		Grade 10		Grade 11		Grade 12	
	Sem. 1	Sem. 2	Sem. 1	Sem. 2	Sem. 1	Sem. 2	Sem. 1	Sem. 2
General Science—9th grade	53%	52%	1%	1%				
Biology—1st year course	14	14	62	62	7%	7%	2%	2%
Biology—college level course (including CEEB AP Biology)			4	4	2	2	9	10
Biology—2nd year course (other than a college level course)			3	4	3	4	12	12
Chemistry—1st year course			9	9	46	46	18	18
Chemistry—college level course (including CEEB AP Chemistry)					4	4	3	3
Chemistry—2nd year course (other than a college level course)					2	2	2	2
Physics—1st year course					12	12	28	27
Physics—college level course (including CEEB AP Physics)							2	2
Physics—2nd year course (other than a college level course)							1	2
Earth Science	7	7					1	1
A physical or biological science course other than those specifically listed	2	2	2	2	4	4	10	9

*The weighted number of seniors (2,647), not the actual number of seniors (1,554), was used as the base for percentages.

Note: Percentages less than 1.0 have been omitted. Although the following courses were listed in the questionnaire, at no grade level were they taken by as many as 1.0% of the students in the sample: aviation or aeronautics, geology, physical geography, astronomy, and a physical or biological science seminar or institute.

TABLE 4

Percentages of Juniors Who Reported Taking Selected Science Courses, Grades 9-11, by Semester

(Based on all 598 juniors)

Course	Grade 9		Grade 10		Grade 11	
	Sem. 1	Sem. 2	Sem. 1	Sem. 2	Sem. 1	Sem. 2
General Science—9th grade	47%	46%				
Biology—1st year course	8	8	48%	48%	24%	24%
Biology—college level course (including CEEB AP Biology)			4	4	6	6
Biology—2nd year course (other than a college level course)			4	4	7	7
Chemistry—1st year course			7	7	35	35
Chemistry—college level course (including CEEB AP Chemistry)					3	3
Chemistry—2nd year course (other than a college level course)					2	2
Physics—1st year course					9	9
Earth Science	12	11				
A physical or biological science seminar or institute						1
A physical or biological science course other than those listed above	2	2	2	2	3	3

Note: Percentages less than 1.0 have been omitted. Although the following courses were listed in the questionnaire, at no grade level were they taken by as many as 1.0% of the students in the sample: physics—college level course (including CEEB AP Physics), physics—2nd year course (other than a college level course), aviation or aeronautics, geology, physical geography, and astronomy.

About one-fourth of the juniors and one-eighth of the seniors took a first-year BSCS course, as shown in Table 5. The difference between the percentages for juniors and seniors may be due, in part, to the fact that the BSCS texts first became commercially available in 1963. Of the seniors 75 per cent were enrolled in biology either in 1963-64 or prior to this date and consequently one would expect a smaller enrollment of seniors in BSCS courses. (Prior to commercial release, the BSCS courses were taught experimentally in some schools but the materials were not available to all schools.)

TABLE 5

Percentage Distributions of First-Year Biology Curriculum*
for Juniors and Seniors
(Based on all students)

Curriculum	Seniors	Juniors
Non-BSCS	88%	74%
BSCS Blue	4	7
BSCS Green	3	5
BSCS Yellow	5	14
Number** of Students		
Unweighted	1,554	598
Weighted	2,647	-

*As indicated by the primary textbook used in the first-year course.

**For seniors, the weighted number of students was used as the base for percentages.

Biological Topics Remembered by Students in Various Courses of Study

In our study of College Board examinees we wanted to determine what topics the student remembered studying in his first-year course. The questionnaire included a list of 103 topics. The topics selected for the questionnaire were for the most part suggested by the Committee of Examiners who guide the preparation of the College Board Biology Test and included topics that were thought to be studied by both BSCS and non-BSCS students and topics that were thought to receive greater emphasis in non-BSCS courses or in one of the BSCS versions. The directions in the questionnaire asked only if the student remembered studying the topic, not if he had understood it. The student was classified as having studied a topic if he carried out the following instruction in the questionnaire:

> Blacken box "C" if you are certain that you had studied the topic in one or more of your biology courses. Also blacken this box if you had learned about the topic both in your biology courses and elsewhere, such as in other courses or through independent study.

The analysis was based on students who had taken only a first-year course in biology.

In order to evaluate independently the degree to which each topic was emphasized in the various types of courses, a non-BSCS text and the three BSCS texts (1, 2, 3) were examined. For analysis purposes the latest version of Modern Biology was used as the non-BSCS text. This, of course, has some limitation due to the fact that not all non-BSCS classes use this text, and some that do use it do not use the latest version. The rationale for using this particular text was based on the results of the questionnaire which indicated that 50 per cent of the total group of non-BSCS seniors and 46 per cent of the total group of non-BSCS juniors stated that they had used Modern Biology as either the primary or secondary text in the first course in biology. The next most frequently used non-BSCS text was used by only 7 per cent of the seniors and 8 per cent of the juniors. Appendix F includes a summary of textbooks used by students in this study.

Two independent reviewers rated the topics. They agreed on the ratings of most of the topics initially and after discussion reached agreement on the other topics. Both the textbook and the laboratory manual were considered in the classification. The coding system used to classify each topic was as follows:

0—if the topic was not found in the textbook;
1—if the topic was found in only one or two places in the text and less than a short paragraph was devoted to the topic;
2—if there were several references and several paragraphs devoted to the topic;
3—and if the topic was given major consideration.

For example,

"Heterotroph Hypothesis" was classified 3 for BSCS Blue Version and 0 for non-BSCS;

"Duodenum" was classified 2 for non-BSCS and 0 for the three BSCS versions;

"Hydrolysis" was rated 3 for non-BSCS and 0 for BSCS Green;

"Effects of Alcohol and Narcotics" was rated 3 for non-BSCS and 0 for all three of the BSCS versions.

It was realized that the problems of classification were greater for the non-BSCS texts than for the BSCS texts. Many of the non-BSCS students would not be using the textbook Modern Biology and for those who did use it, the particular edition studied would affect the classification given to a topic. For example, the term Pteridophyta which is used to a great extent in the older editions of Modern Biology is not used in the latest edition.

Appendix B lists the topics, the rating of the relative emphasis given each one by the texts of the four curricula, and the percentages of juniors and seniors (in each curriculum) who said they recalled studying each topic. Figures 1-4 summarize student response in each curriculum. To illustrate how the graphs were developed let us use Figure 1. The percentages of non-BSCS students who recalled studying each topic with a "0" textbook rating were totaled, and the mean percentage was figured for all "0" topics. The same computation was done for the "1," "2," and "3" topics. Thus, the mean percentage of non-BSCS students indicating that they had studied topics not included in the text ("0" rating topics) was 28 per cent for the seniors and 30 per cent for the juniors.

The data presented in Appendix B and Figures 1-4 support the following conclusions. (1) A great majority of the students in each of the four first-year curricula remembered the major points in the textual material of their courses. For example, 85 per cent of the seniors and 97 per cent of the juniors indicating that they had used BSCS Blue Version stated that they had studied the Heterotroph Hypothesis which receives heavy emphasis in the text. (2) The greater the emphasis of topics in the text the greater the number of students who recalled them. (3) In view of the sizable percentages of students who reported studying topics not found in the appropriate texts, it may be inferred that a good deal of additional material had been introduced into each of the courses.

FIG. 1

Mean Percentages of Non-BSCS Students Who Recalled Studying Topics in the Questionnaire in Relation to the Emphasis Given These Topics by Their Texts

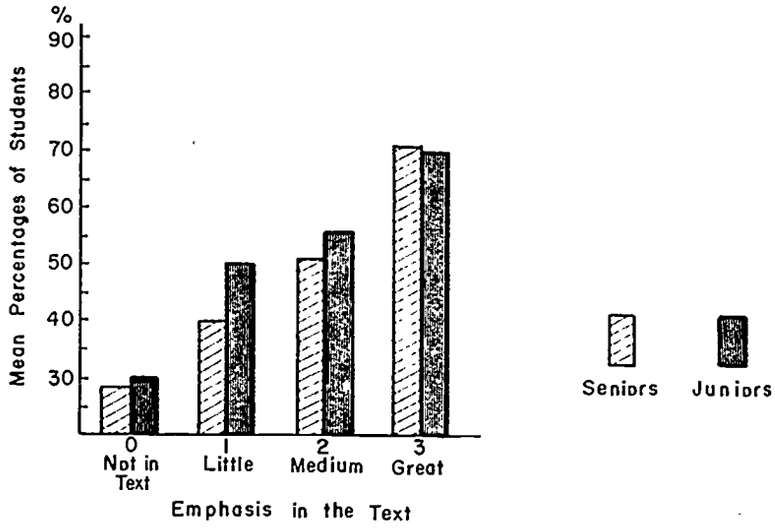


FIG. 2

Mean Percentages of BSCS Blue Version Juniors and Seniors Who Recalled Studying Topics in the Questionnaire in Relation to the Emphasis Given These Topics by Their Texts

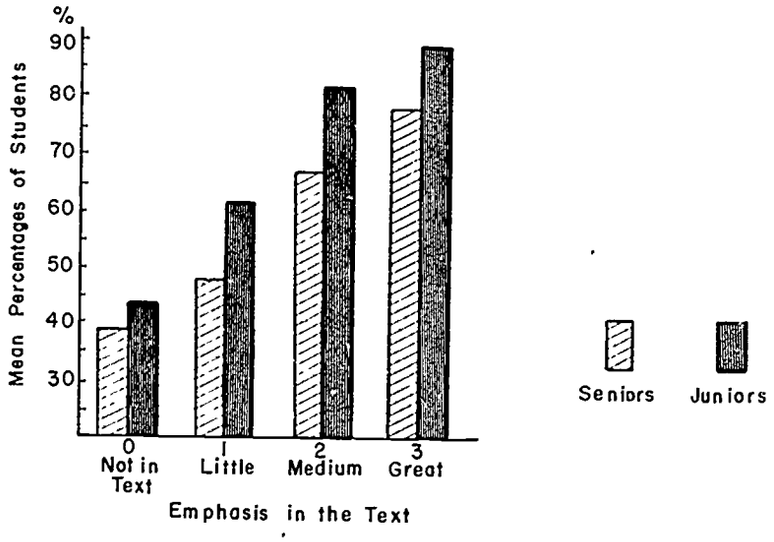


FIG. 3

Mean Percentages of BSCS Yellow Version Juniors and Seniors Who Recalled Studying Topics in the Questionnaire in Relation to the Emphasis Given These Topics by Their Texts

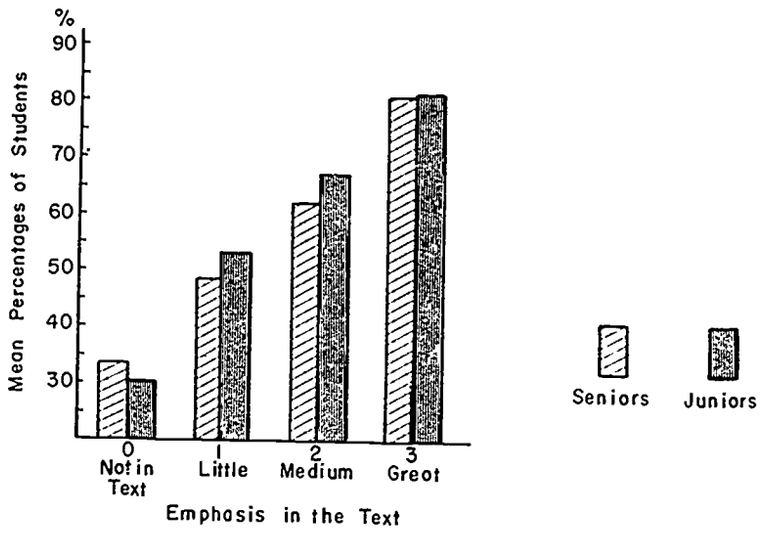
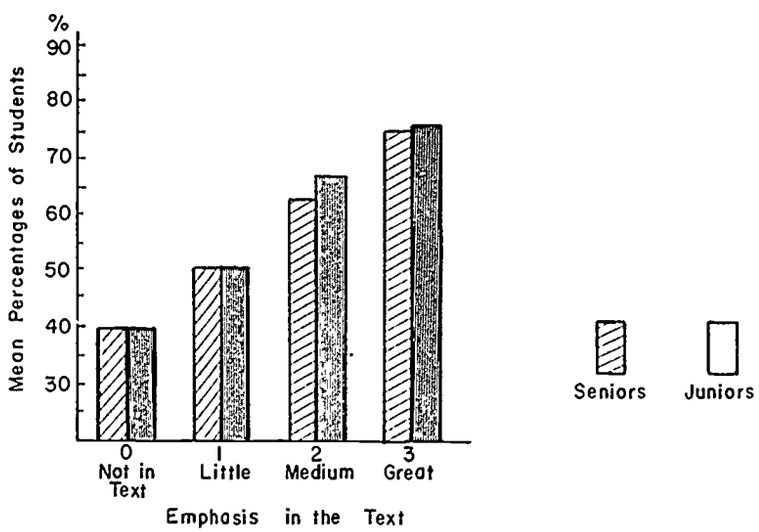


FIG. 4

Mean Percentages of BSCS Green Version Juniors and Seniors Who Recalled Studying Topics in the Questionnaire in Relation to the Emphasis Given These Topics by Their Texts



The next analysis of the candidates' first-year biology courses was a comparison of the biological levels studied by each of the curricular groups. Both the emphasis given each level in the texts and the students' recall of topics in these areas were analyzed. The model used for the analysis was the Relative Emphasis of Biological Levels developed by BSCS in 1963. The levels defined were molecular, cellular, organ and tissue, individual, population, community, and world biome. In the BSCS study 12 non-BSCS teachers were asked to indicate on a six-point scale the relative emphasis they gave to each of the biological levels in their courses. 0 is no emphasis and 6 equals great emphasis. Their responses are summarized in Figure 11. This figure also shows ratings of the relative emphasis given to the various levels in the 1965 edition of Modern Biology, based on the publisher's analysis using the same six-point scale for relative emphasis. Although the results of the two analyses of the non-BSCS curriculum are not in close correspondence, both analyses indicated that organ and tissue level of biology was the most highly emphasized. The supervisors in charge of each of the three BSCS writing teams, consisting of research biologists, college or university, and high school biology teachers were asked to indicate, on the same six-point scale, the relative emphasis given each level in the BSCS text for which they were responsible. Comparisons of each BSCS text with the conventional texts are given in Figures 5, 7, and 9.

The directors of the present study classified each of the topics in the student questionnaire as to its biological level. As a check the topics were classified by two independent reviewers. Then, the percentages of students who indicated that they had studied each molecular topic, for example, were totaled and the average percentage was calculated. This was done with the topics in each biological level for the non-BSCS group and the three BSCS groups. The results are summarized in Figures 6, 8, 10, and 12.

When one compares Figures 5 and 6, the supervisor of BSCS Blue Version indicated that the major emphasis of BSCS Blue Version (Figure 5) was molecular and cellular. This seems to be well substantiated by the manner in which Blue Version students (Figure 6) responded to those topics that were molecular and cellular in the questionnaire.

When one compares Figures 7 and 8, the supervisor of BSCS Yellow Version stated that the greatest emphasis was also molecular and cellular and this is also substantiated by the students' responses to the questionnaire.

In Figure 9, population, community, and world biome are the areas of greatest emphasis in BSCS Green Version. This is reflected to a degree by the students' responses summarized in Figure 10. The greatest discrepancy comes in the area of cell biology where the responses to the questionnaire indicate that the candidates studied more cellular topics than would have been expected from the supervisors' analysis.

Figure 11 indicates that non-BSCS courses emphasize organ and tissue, cellular and individual organism. This analysis is substantiated by the results of the survey (Figure 12) as it pertains to cellular and organ tissue levels but not to individual organisms. Also the students indicated less emphasis in the non-BSCS courses on organ and tissue than would be expected from the teachers' analysis in Figure 11.

Figure 13 represents a composite of the data pertaining to emphasis on biological levels as stated by the three BSCS supervisors, the teachers who estimated the emphasis of conventional texts, and the emphasis of the 1965 edition of Modern Biology according to the publishers of this text.

Figure 14 represents a composite of the mean percentage of students in BSCS Blue, Green, and Yellow, and non-BSCS courses who stated they had studied the various topics.

It is apparent from Figures 13 and 14 that the responses of the students are very similar to analyses of the teachers, supervisors, and publishers. The discrepancies that occur may be due to improper sampling of the topics in these areas or to the fact that a considerable amount of material in addition to the texts is introduced by the teachers of the students represented in the questionnaire. The topics in the questionnaire represent only a sample of the topics that would be found in the textbooks discussion of molecular biology, cellular biology, and the other levels that we have defined. However, if the supervisors' and teachers' analyses of the texts are reliable criteria, the students recall of topics in the questionnaire correlates highly with the emphasis in each of the textbooks.

FIG. 5

Content and Emphases of the BSCS and Conventional Texts

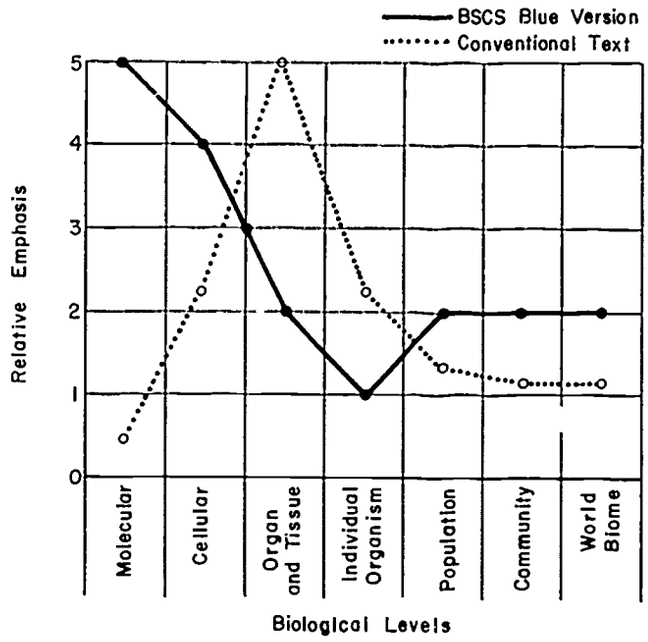


FIG. 6

Biological Levels of the Topics Recalled by BSCS Blue Version Juniors and Seniors

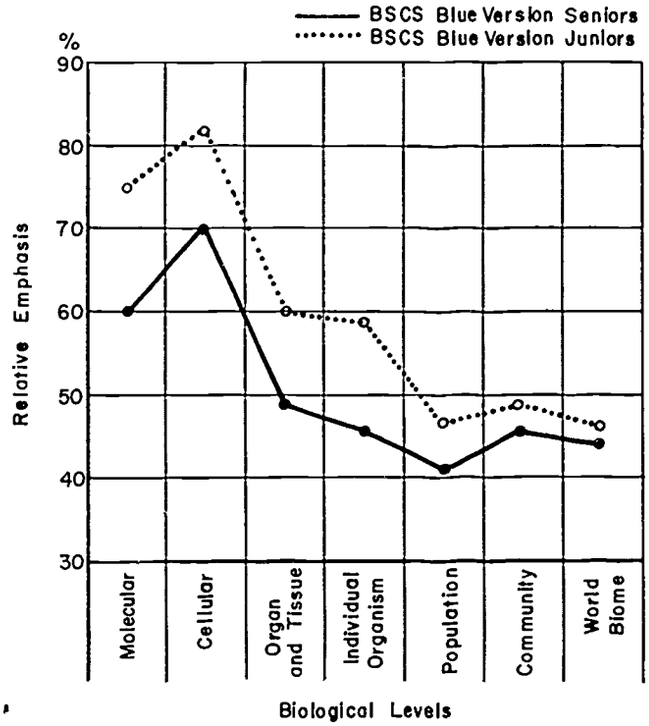


FIG. 7

Content and Emphases of the BSCS and Conventional Texts

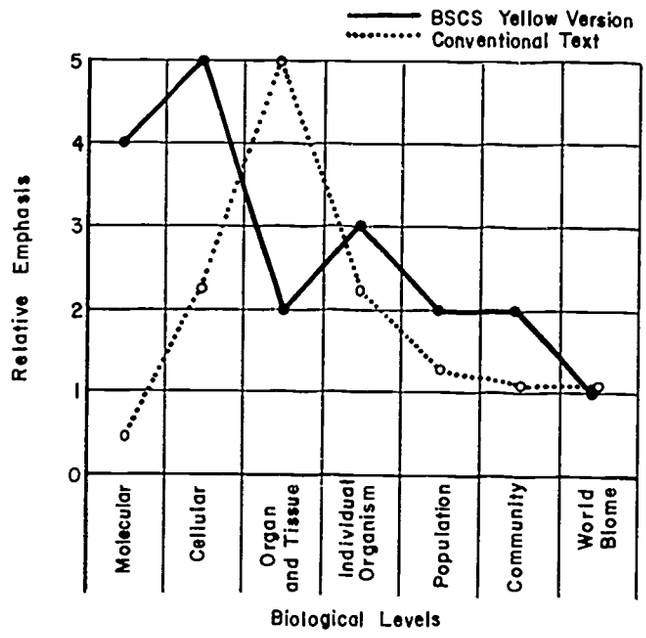


FIG. 8

Biological Levels of the Topics Recalled by BSCS Yellow Version Juniors and Seniors

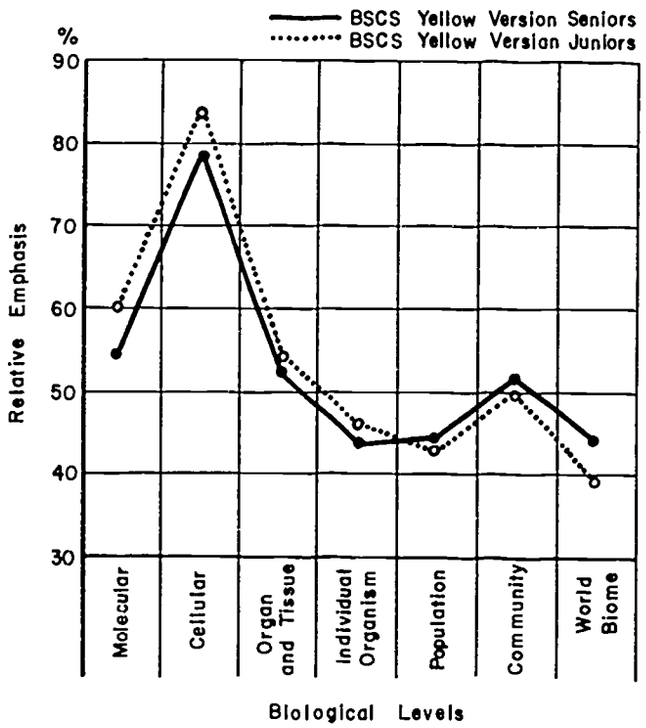


FIG. 9

Content and Emphases of the BSCS and Conventional Texts

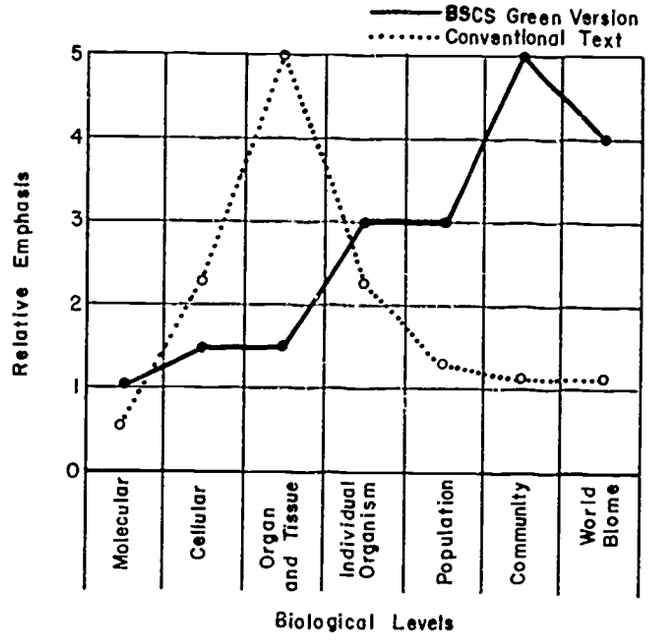


FIG. 10

Biological Levels of the Topics Recalled by BSCS Green Version Juniors and Seniors

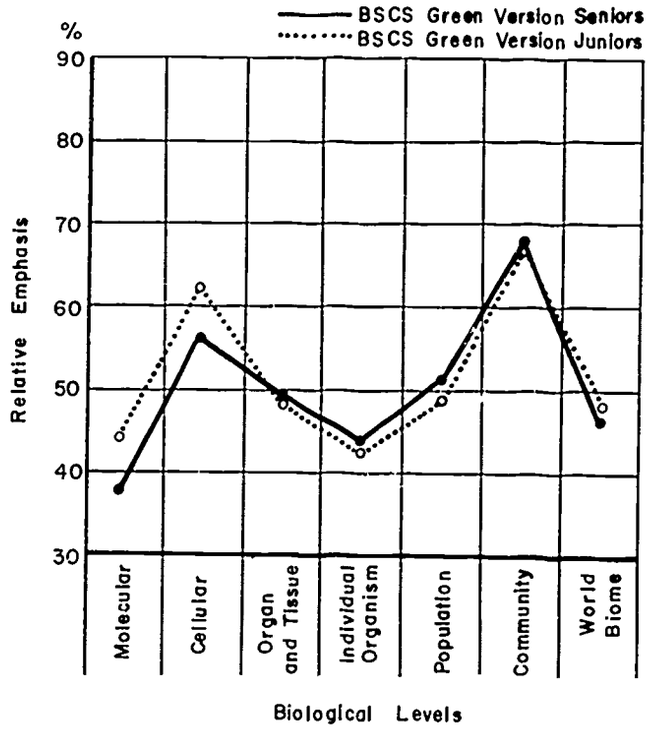


FIG. 11

Content and Emphases of Conventional Texts

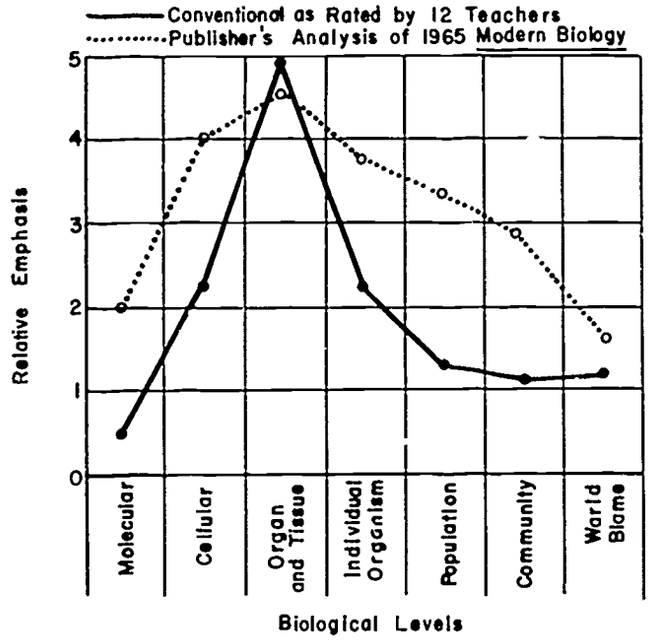


FIG. 12

Biological Levels of the Topics Recalled by Non-BSCS Juniors and Seniors

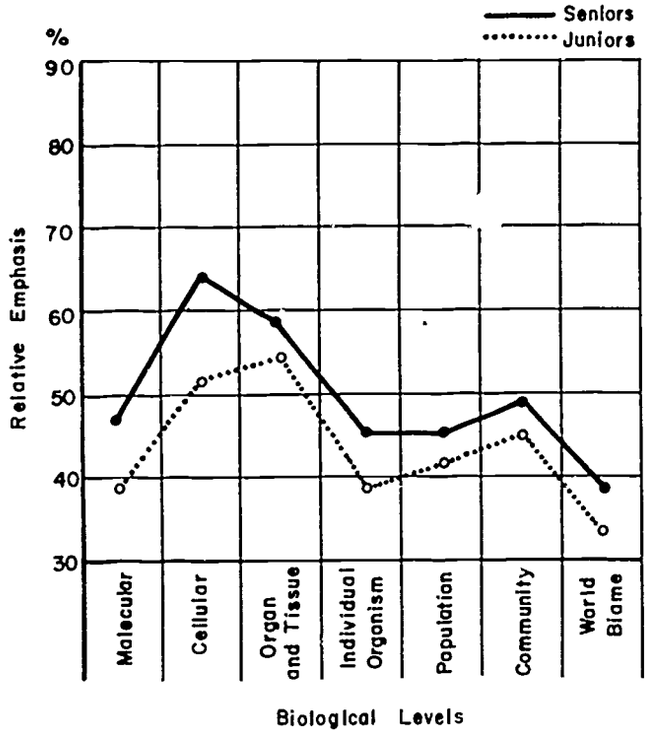


FIG. 13

Summary: The Relative Emphases of BSCS and Conventional Texts as Evaluated by BSCS Supervisors, Teachers, and Textbook Publishers

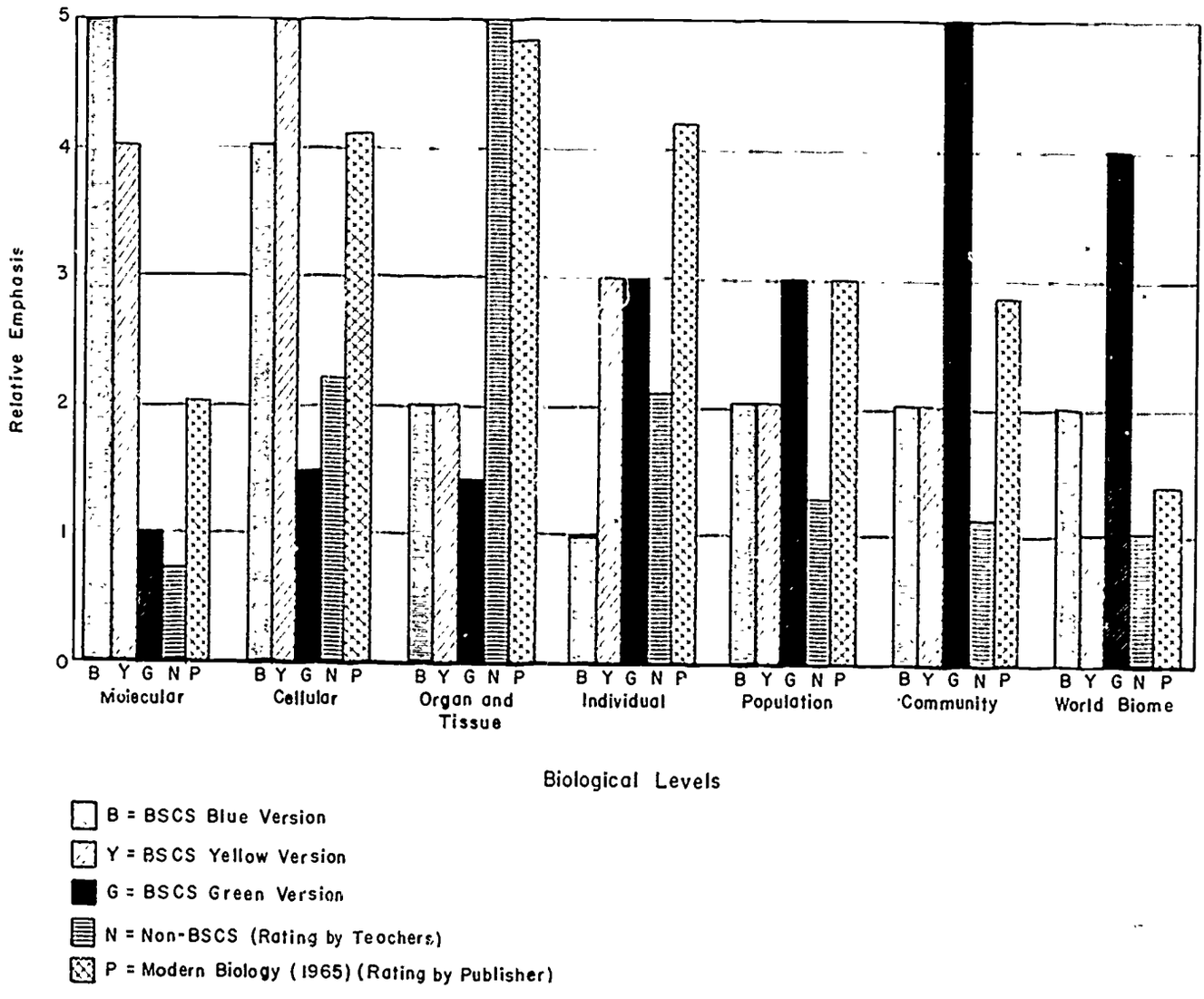
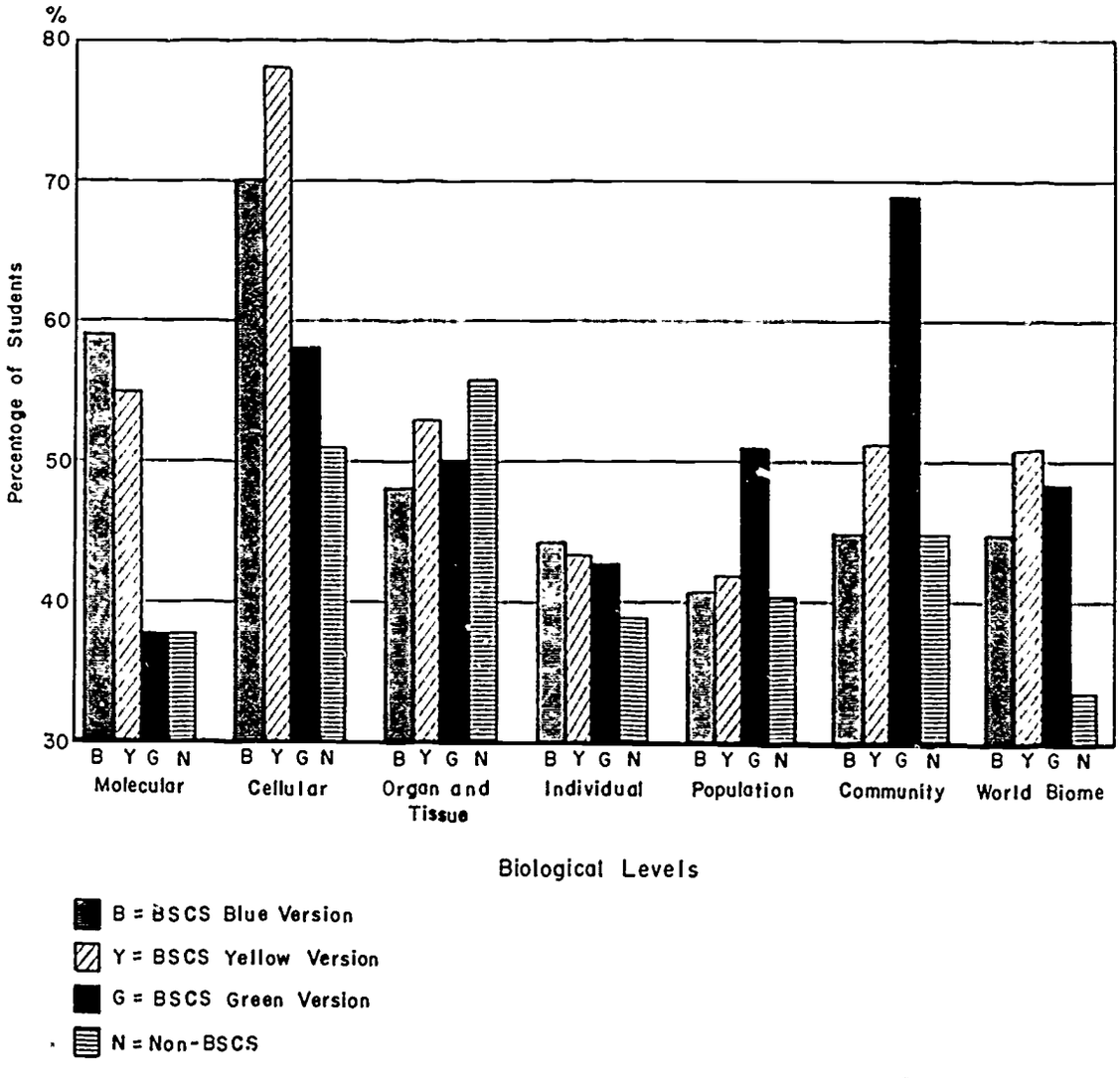


FIG. 14

Summary: The Biological Levels of Topics Recalled by Seniors who had had First-year Biology Only



Laboratory Work

In recent years there has been an attempt to restructure the laboratory experience of the secondary school biology student. The intent of the restructuring was to decrease the number of laboratories that were mainly centered on the dissecting of plants and animals and to increase the number of activities that included an experimental approach. In order to give us some insight into the nature of laboratory work in the first-year course, the students were asked to indicate whether they had participated in selected laboratory activities. Laboratory work was divided into laboratory experiences that involved dissection, those experiments that were of an investigative nature, and activities such as field trips with the primary purpose of collecting and/or identifying specimens. Responses were tabulated for students who reported having taken only a first-year course in biology. In Appendix C the results of the tabulations are presented for each of the laboratory activities.

The section of the questionnaire on dissection instructed the candidates as follows:

Blacken box "P" if you had performed the dissection yourself or with a partner in a biology course;

Blacken box "D" if you had seen the dissection demonstrated in a biology course but had not done it yourself.

The percentages of juniors and seniors in the various curriculums who reported that they had performed the dissections are summarized in Appendix C, in which the dissections have been classified by whether or not they were included in the appropriate laboratory manual. The laboratory manual used for non-BSCS students was the manual accompanying Modern Biology. The data in Appendix C indicate that although dissections that were included in the laboratory manual were performed more frequently than those that did not appear in the manual, the latter were also used.

Some interesting departures from the laboratory approaches in the area of dissection are listed in the following summary. The lists include dissections that, although they were not listed in the appropriate laboratory manual, had been performed by more than a fifth of the seniors in the sample. The figures in parentheses indicate the percentages of seniors who reported that they had performed the dissections.

BSCS Blue—Seed (41%)
Earthworm (32%)
Insect (31%)
Fruit (25%)
Roundworm (Ascaris) (25%)

BSCS Green—Earthworm (68%)
Insect (51%)
Crayfish or Lobster (39%)
Fish (39%)
Seed (34%)
Fruit (30%)
Roundworm (Ascaris) (25%)
Moss (22%)

BSCS Yellow—Insect (35%)
Fish (29%)
Fruit (25%)
Seed (25%)

In the section of the questionnaire concerned with topics that are sometimes investigated experimentally in biology courses, the students were given the following instructions:

Blacken box "C" if you had conducted an experiment on the topic yourself or with a partner in one of your biology courses;

Blacken box "D" if you had seen an experiment on the topic demonstrated in one of your biology courses but had <u>not</u> done it yourself.

The percentages of juniors and seniors in the various curriculums who reported that they had conducted the experiments are summarized in Appendix C. The experiments have also been classified by whether or not they were included in the appropriate laboratory manual.

For laboratory work involving investigative procedures the following major deviations from the laboratory manuals were reported. The lists include investigative activities that, although they were listed in the appropriate laboratory manual, had been performed by no more than one-fifth of the seniors in the sample. The figures in parentheses indicate the percentages of seniors who reported that they had engaged in the activities.

Non-BSCS—Development of frog embryos (5%)
Development of chick embryos (6%)
Genetic study with Drosophila (fruit fly) (7%)
Phototropism in plants (18%)

BSCS Blue—Transpiration using a potometer (9%)
Respiration using a volumeter (15%)
Plant growth hormones (15%)

BSCS Green—Transpiration using a potometer (0%)
Development of frog embryos (3%)
Development of chick embryos (12%)
Genetic study with Drosophila (fruit fly) (19%)
Paper chromatography (19%)
Spontaneous generation (20%)

BSCS Yellow—Development of frog embryos (6%)
Plant growth hormones (7%)
Development of chick embryos (17%)
Phototropism in plants (18%)

The third aspect of laboratory work—field trips and collecting—plays a role in all four curriculums with greatest emphasis in the BSCS Green Version. Students' answers about their participation in these activities are summarized in Table 6.

TABLE 6

Percentages of Students Who Reported Participation in Selected Field Activities for Students Classified by First-Year Biology Curriculum
(Based on students who reported taking only a first-year course in biology)

	Non-BSCS		BSCS Blue		BSCS Green		BSCS Yellow	
Field Activity	Srs.	Jrs.	Srs.	Jrs.	Srs.	Jrs.	Srs.	Jrs.
Went on one or more field trips to observe bird life	10%	7%	15%	6%	15%	3%	6%	12%
Collected and classified insects	20	14	13	15	34	20	15	16
Collected and classified leaves	34	17	31	21	34	30	24	21
Observed life in pond water	47	43	68	53	76	57	50	63
Number* of Students								
Unweighted	820	371	39	32	33	24	51	76
Weighted	1,397	...	68	...	59	...	84	...

*For seniors, the weighted number of students was used as the base for percentages.

Scientists

The committee of examiners was also interested in the part that the history of biology played in the first-year course. Of special interest was the extent to which information on contemporary biologists has been introduced into present-day courses.

The students were asked to indicate if the work of the scientists listed in the questionnaire had been discussed in their biology course. Responses were tabulated for those students who reported taking only a first-year course in biology. In the analysis the students were classified by curriculum and the scientists were classified by whether or not they were mentioned in the appropriate text. Again, Modern Biology was the non-BSCS text used as the basis for classification. The results for individual scientists are shown in Appendix D.

The student responses, in general, were reasonably consistent with the names listed in the indexes of the texts, although more than one-third of the students in the sample of seniors reported class discussion of the following scientists who were not listed in the indexes of their texts.

BSCS Blue—Luther Burbank (37%)

BSCS Green—Luther Burbank (51%)
William Harvey (47%)
Francesco Redi (44%)
Melvin Calvin (37%)

BSCS Yellow—Luther Burbank (62%)

Class Length and Number of Meetings

The students were asked the following questions about the scheduling of their first course in biology.

Approximately how much time per week, on the average, did you spend in laboratory work in your first course in biology? Consider that laboratory work means making observations or conducting experiments on your own, or with a partner, or with a small group of follow students.

What was the average number of class periods a week that your class met in your first course in biology including time spent on laboratory work? If the class met for one or more double periods, count them according to the number of equivalent single periods.

What was the average length of a single class period in your first-biology course?

The responses were tabulated for all students, including those who had taken more than one biology course. The results are presented in Appendix E.

If 45 minutes is considered the minimum period, the percentages of students who had the equivalent of less than one period of laboratory per week range from 10 per cent for Yellow Version BSCS seniors to 23 per cent for non-BSCS seniors and from 10 per cent for Blue and Yellow BSCS juniors to 15 per cent for non-BSCS juniors. The percentages of students who indicated that they had one and one-half hours or more of laboratory work per week, ranged from 38 per cent of the seniors in non-BSCS courses to 65 per cent of those in Green Version BSCS courses. The range for juniors was from 47 per cent of the non-BSCS students to 64 per cent for the Blue Version BSCS juniors.

As for classroom periods (including laboratory work), five was the most common number of periods a week. A small percentage of the seniors stated that they met less often. More than five periods a week were reported by seniors as follows: 16 per cent of the BSCS Green students, 23 per cent of the BSCS Blue, 38 per cent of the BSCS Yellow, and 26 per cent of non-BSCS students.

And among the BSCS juniors more than five periods a week were indicated by 31 per cent of the Green, 51 per cent of the Blue, 62 per cent of the Yellow. For non-BSCS juniors the percentage meeting more than five periods a week was 46. The percentages of juniors reporting class periods of less than 50 minutes were greater than the corresponding percentages of seniors.

The number of class periods per week varied with the type of school that the student attended and the area in which the school was located. The results for students classified on these bases cannot be assumed to reflect typical differences in scheduling among the schools in the various categories, since not only are the study samples quite small but they are differentially representative of the corresponding groups of students in the national population of secondary school students. Some of the results for the seniors in the sample were as follows.

The majority (72 per cent) of public school students had biology five periods a week whereas only 46 per cent of the Roman Catholic school students and 44 per cent of the independent school students met five times a week. Although only a few students in public and Roman Catholic schools met for less than five periods a week, 19 per cent of the independent school students did meet for less time. The percentage of the students meeting six or more periods per week were: 21 per cent in public schools, 50 per cent in Roman Catholic schools, and 37 per cent in independent schools. Of the public school class periods, 51 per cent were reported as 50 minutes or longer, whereas 26 per cent of the Roman Catholic students and 39 per cent of the independent school students met for this length of time.

The schools in the Northeast and Midwest regions of the United States showed the highest percentages of students who attended biology classes for more than five periods a week. In the Northeast 36 per cent of the students and in the Midwest 21 per cent of the students had more than five periods per week. Only 5 per cent of the students from the South and 8 per cent of the students from the West attended class more than five periods per week.

The data on length of class period indicate that 78 per cent of the students in the Northeast, 26 per cent in the Midwest, 11 per cent in the South, and 21 per cent in the West attended class periods that were 40-49 minutes long. The typical time pattern for the Midwest, South, and West was 50-59 minutes.

It will be noted that, generally, the subgroups in which a relatively high percentage of students reported shorter-than-average class periods are also the groups in which a relatively high percentage of students reported a comparatively large number of class periods per week.

Second-Year Course in Biology

All students in the sample were asked if they had taken a second-year course in biology. Of the seniors, 39 per cent said they had taken a second course, and of the juniors, 16 per cent.

The students who had taken a second course were asked to indicate the title of the course and its prerequisites, if any. The results are shown in Tables 7 and 8. It should be noted that some students had taken more than one advanced course and consequently the percentages of students who took the various kinds of second year courses, when totaled, exceed 100. The two leading types of courses reported by seniors were Advanced Biology (51 per cent) and Physiology (23 per cent). Of the seniors who had taken a first year BSCS course, 53 per cent indicated that they then took Advanced Biology and 33 per cent took the BSCS Second Level course.

The prerequisites most frequently mentioned by the seniors were: B average in first biology course (reported by 33 per cent), permission of the instructor (reported by 36 per cent), and prior or concurrent work in chemistry (reported by 36 per cent).

The pattern of requirements reported by the juniors seems to be similar to that of the seniors in that the majority of students were enrolled in Advanced Biology courses (45 per cent) and in Physiology (20 per cent). One major difference between the juniors and seniors is that only 17 per cent of the juniors indicated prior or concurrent work in chemistry as a prerequisite of admission to the second year biology course.

TABLE 7

Titles and Requirements of Second Courses in Biology Taken or Being Taken by Samples of Seniors Who Took the College Board Biology Achievement Test in December 1965 and January 1966

	Per Cent in Total Sample	Per Cent in S.S. Grouped by Type and Geographical Location						
		Public	Roman Cath.	Inde-pendent	North-east	South	Mid-west	West
	(n = 1554)	(n = 1276)	(n = 242)	(n = 45)	(n = 807)	(n = 139)	(n = 364)	(n = 244)
Have you taken (or are you now taking) a second course in biology?								
A. Yes	39%	42%	22%	46%	36%	47%	37%	48%
B. No	61	58	78	54	64	53	63	52
If your answer was "yes," please indicate the course(s) that you took or are now taking.	(n = 611)	(n = 539)	(n = 51)	(n = 21)	(n = 294)	(n = 64)	(n = 134)	(n = 119)
A. Advanced Placement Biology	13	13	12	19	17	17	9	7
B. Advanced Biology	51	51	47	48	53	55	54	40
C. Physiology	23	24	20	24	22	16	21	30
D. General Botany	4	4	0	0	1	3	6	8
E. General Zoology	5	26	2	0	4	0	10	5
F. BSCS Second Level Biology	8	6	0	19	5	8	8	15
G. Biology Seminar	4	4	4	0	5	5	1	4
H. Other	16	16	8	19	15	20	14	15
Indicate the requirement(s) you had to satisfy in order for you to be admitted to the course(s) which you specified above.								
A. No special requirements for the second course in biology taken	21	22	35	57	19	27	29	29
B. B average or better in all academic subjects	10	10	8	10	10	14	10	11
C. B grade or better in first biology course	33	33	24	14	33	27	34	29
D. Permission of the instructor	36	36	37	19	36	39	34	34
E. Prior or concurrent course work in chemistry	36	36	25	14	39	33	30	28
F. Prior or concurrent course work in physics	12	12	10	0	13	3	13	9
G. Other	18	18	10	5	18	19	17	15

TABLE 8

Titles and Requirements of Second Courses in Biology Taken or Being Taken by Samples of Juniors Who Took the College Board Biology Achievement Test in May 1966

	Per Cent in Total Sample	Per Cent in S.S. Grouped by Type and Geographical Location						
		Public	Roman-Cath.	Inde-pendent	North-east	South	Mid-west	West
	(n = 598)	(n = 410)	(n = 90)	(n = 98)	(n = 477)	(n = 54)	(n = 37)	(n = 30)
Have you taken (or are you now taking) a second course in biology?								
A. Yes	17%	19%	4%	14%	14%	20%	27%	23%
B. No	83	81	96	86	86	80	73	77
If your answer was "yes," please indicate the course(s) that you took or are now taking.	(n = 95)	(n = 77)	(n = 4)	(n = 14)	(n = 67)	(n = 11)	(n = 10)	(n = 7)
A. Advanced Placement Biology	17	19	0	7	22	0	10	0
B. Advanced Biology	45	45	0	43	37	100	40	29
C. Physiology	20	21	50	14	24	9	10	14
D. General Botany	2	3	25	0	1	9	0	0
E. General Zoology	6	8	0	0	9	0	0	0
F. BSCS Second Level Biology	9	9	0	14	9	0	10	29
G. Biology Seminar	1	1	0	0	1	0	0	0
H. Other	14	14	25	7	13	9	20	14
Indicate the requirement(s) you had to satisfy in order for you to be admitted to the course(s) which you specified above.								
A. No special requirements for the second course in biology taken	23	19	0	50	22	0	40	43
B. B average or better in all academic subjects	9	12	0	0	10	9	10	0
C. B grade or better in first biology course	34	38	50	7	36	45	30	0
D. Permission of the instructor	34	32	100	21	34	55	20	14
E. Prior or concurrent course work in chemistry	17	19	0	7	16	27	10	14
F. Prior or concurrent course work in physics	0	0	0	0	0	0	0	0
G. Other	14	17	0	0	13	18	10	14

Summary and Conclusions

1. The majority of students taking the College Board Examinations in Biology also take a secondary school course in chemistry and a large number also take a course in physics.
2. College Board biology achievement candidates most often take biology in the tenth grade. However there was a tendency for juniors (24 per cent) to take biology in their junior year.
3. The degree to which a student remembered whether a topic had been discussed in class correlated highly with the emphasis given the topic in the textbook. The topics related to the biological levels (molecular, cellular, organ and tissue, etc.) emphasized in the text used by the student were those remembered to the highest degree by the students. BSCS Blue Version and BSCS Yellow Version students best remembered the molecular and cellular topics; BSCS Green Version those topics that were ecology oriented; and non-BSCS those topics that were oriented toward cellular level and organ and tissue.
4. There were topics introduced into the classroom that were not included in the textbooks.
5. Reflecting the apparent trend in secondary school biology, there appears to be considerable emphasis on molecular and cellular topics in the school courses.
6. One of the limitations of this study is the relatively small number of BSCS students taking the examination. A higher percentage of juniors took BSCS courses than did seniors. This might be associated with the availability of BSCS texts commercially in 1963.
7. The laboratory material accompanying the texts used in the various curriculums is liberally supplemented by laboratory exercises from other sources.
8. Juniors and seniors did not differ significantly in their responses to the topics that they remembered studying and to the types of laboratories included in their courses.
9. The laboratory experiences of the students indicate that there are today various types of laboratories and a considerable departure from the classical dissection approach to laboratory work.
10. The great majority of the students had at least one 45 minute laboratory per week.
11. There is some familiarity with the work of various scientists with an increasing awareness of some of the more contemporary scientists.
12. A sizable portion of students had two or more hours of laboratory per week.
13. There was a significant number of students (26 per cent of the seniors and 48 per cent of the juniors) whose biology classes met more than five times per week. This may be indicative of double laboratory periods and/or modular scheduling.
14. A large percentage of seniors (39 per cent) was enrolled in a second course in biology. Most of these students took a course labeled Advanced Biology and had to meet various requirements to be admitted to the course. Prior or concurrent course work in chemistry, permission of the instructor, and a B grade or better were the requirements most often cited.

Appendix A

Description of Design and Administration of Survey

Sampling Plan

The sampling frame for this survey included all students who had taken College Board achievement tests in December 1965, January 1966, and March 1966 and juniors who had taken these tests in May 1966. However, college and postgraduate students and students attending secondary schools located in areas other than the 50 states were excluded.

Samples of equal size were drawn for all tests within an administration. The sampling procedure based the selection of students on the last three digits of the student registration number, the assumption being that these digits are randomly distributed. However, because no student was to be included in more than one sample within an administration, the selection method was not strictly random. The few students who happened to be drawn for two samples were excluded from the sample for the more popular test.

Nine hundred and seventy-five cases were selected in each subject from each of three administrations (December, January, and May) and 675 cases from the March administration. Since duplication could occur across administrations, the students were requested to complete only the first questionnaire received. The total n was approximately 38,000 students from 50 states and 7,555 secondary schools. The sample size for each subject is given in the first column of the Response Summary. Whenever the data from samples from several administrations or samples from different tests within an administration were combined for presentation in one of these reports, the responses were weighted in proportion to the total population that they represented.

Description of the Questionnaires

Each of the 10 questionnaires used in this survey had three parts. Part I described general course work in grades 9 through 12 in seven general areas: English, mathematics, history and social studies (including social sciences), foreign languages (modern and classical), science, art and music, and practical arts. Part II provided detailed information on the specific courses taken by the student in one of five general areas (area dependent upon the test for which the student was selected). Part III focused primarily on either course content or methodology in the subject in which the student took a College Board achievement test.

Testing specialists from Educational Testing Service, working with committees of examiners in each subject, formulated the questionnaires and assisted in planning the analysis. The following kinds of questions were included in Part III.

1. Questions that sought to determine the extent to which new topics or emphases were being introduced or old topics and emphases were being dropped.

2. Questions designed to identify subgroups of students whose preparation deviated systematically from all other subgroups or from the general group.

3. Questions that would yield evidence of the variability in breadth and depth of subject-matter coverage.

4. Questions that would reveal variability in elements or aspects of the curriculum not necessarily related to secondary school curriculum-reform movements. These included questions based on presumably stable portions of the curriculum which not only would serve as additional evidence of construct validity but also would provide a means for tracing curricular change in the future.

5. Questions that would provide a check on the reliability and validity of candidates' responses. These included somewhat differently worded questions bearing on the same topic as well as questions geared to different levels of specificity or generality.

The instructions for answering the questions in Part III generally were related to when students took specific tests. In most cases, if they took the test in December or January, they were to report on what they had studied in that subject through the fall (or first semester) of the 1965-66 academic year; if they took the test in March, they were to report on what they had studied up to the time they took the test; if they took the test in May, they were to report on what they had studied as of the end of the 1965-66 academic year, which, in this case, was the end of the junior year. However, for languages, because the emphasis was on methodology rather than content, students reported only for the grades in secondary school in which they had studied the language for at least one semester.

Administration of the Questionnaires

Each questionnaire was accompanied by a general letter of invitation which emphasized the desirability for accurate information and urged students to seek their teachers' assistance, whenever necessary. The mailing addresses were those provided by the students on their registration forms. In most cases, these were the students' home addresses. A code number consisting of six digits was preprinted on each Part I answer sheet. The first digit identified questionnaire part (Part I, II, or III), the second digit identified subject, and the last four digits identified the student.

Access to a special tape was a convenient means for obtaining information, such as test scores (including scores on all achievement tests and on the SAT), secondary school, and, in some instances, background information on candidate preparation in the subject in which he took the test. It also provided a system for informing principals as to which students in their schools received questionnaires and which students had not returned completed forms.

Response to Survey

The excellent cooperation of both students and principals resulted in returns from three-fourths of the candidates contacted. However, about 5 per cent of the returns, for one reason or another, were not usable. As noted below, these responses vary—from a low of 60% for those who took the American History and European History tests to a high of 75 per cent for those who took the French and Physics tests.

In addition, many letters were received from students, teachers, and administrators indicating their appreciation of the fact that the College Entrance Examination Board wanted to prepare tests that reflected the secondary school preparation of the students who took them. Thus, students would be assured an equal opportunity of showing on the tests what they had learned even though their secondary school programs were different.

RESPONSE SUMMARY

Test	Number contacted	Number of usable returns	Per cent response
English	3,474	2,313	67
American History European History	5,137	3,079	60
French	3,486	2,600	75
German	3,487	2,579	74
Spanish	3,452	2,447	71
Latin	3,540	2,595	73
Mathematics Level I Mathematics Level II	5,448	3,769	69
Biology	3,379	2,275	67
Chemistry	3,338	2,458	74
Physics	3,373	2,513	75
Totals	38,114	26,628	70%

Additional Comments

It is important to note that the students submitting data for these reports represent an atypical group of prospective college students. Compared with a national sample of college entrants, in College Board Score Reports, ... 1968-69, p. 25, they rank close to the 75th percentile on the Scholastic Aptitude Test in both verbal and mathematical scores.

It is not too surprising to find that this is an extremely able group because, other things being equal, colleges that use achievement tests put emphasis on the ability and preparation of their students. For example, it is interesting to note that of the 177 colleges and universities described by Cass and Birnbaum (Comparative Guide to American Colleges) as most selective, highly selective, or very selective, 130 of them required College Board achievement tests for admission in September 1966.

APPENDIX B

Biological Levels and Ratings of Textual Emphasis of Selected Topics and Percentages of Students Who Reported Study of the Topics for Students Classified by First-Year Biology Curriculum and Educational Level

(Based on students who reported taking only a first-year course in biology)

		Non-BSCS			BSCS Blue			BSCS Green			BSCS Yellow		
			Per Cent			Per Cent			Per Cent			Per Cent	
Topic	Level	Rating	Srs.	Jrs.	Rating	Srs.	Jrs.	Rating	Srs.	Jrs.	Rating	Srs.	Jrs.
Acetylcholine	M	1	29%	34%	1	38%	63%	0	3%	8%	1	43%	47%
Active transport	Ce	2	29	47	3	82	100	2	53	71	2	77	82
Alternation of generations	P	2	84	87	0	69	78	2	88	83	3	85	92
Amino acids	M	3	90	90	3	97	100	2	97	92	3	100	95
Antibodies	M	3	90	88	0	87	88	1	93	88	3	95	92
Arachnida	P	2	69	70	1	34	47	2	71	71	1	45	43
Autotrophs	W	2	39	59	3	88	100	0	44	50	2	70	79
Auxin (plant hormones)	O	2	51	62	2	65	81	2	49	79	3	77	79
Bacterial transformation	M	2	42	35	1	34	38	0	34	33	0	32	46
Bacteriophage	Ce	3	36	42	2	44	72	1	41	29	3	80	88
Biological clocks	I	1	21	22	0	37	31	0	29	21	0	25	13
Bioluminescence	M	0	17	15	0	10	9	1	41	38	0	12	8
Biomes	W	3	24	27	0	13	22	3	66	67	0	23	16
Cambium	O	2	74	82	1	50	81	1	66	71	3	65	83
Carotene	M	1	65	71	0	47	38	0	41	25	1	32	32
Centromeres	Ce	1	28	37	0	44	72	0	22	29	2	65	80
Chromatography	M	0	42	34	3	66	31	3	47	42	2	43	37
Climax forest	Co	1	40	47	2	44	47	0	61	63	1	44	47
Coacervates	M	0	11	7	3	79	100	0	10	8	0	14	5
Coelacanths	P	1	21	25	0	15	3	2	42	25	0	23	4
Communication among honeybees	I	2	44	44	3	40	50	1	47	25	0	17	14
Connective tissue	O	2	86	88	0	72	66	0	78	67	0	70	66
Consumer (Primary)	Co	1	43	57	1	40	53	2	75	92	3	80	86
Crossing over	Ce	2	63	79	1	85	88	3	76	79	2	68	86
Cytochrome	M	0	38	29	0	44	38	0	39	29	1	54	38
Cultural evolution	W	0	44	37	0	47	34	0	53	46	3	52	42
Diptera	P	3	52	46	0	22	19	0	51	42	0	24	17
DNA	M	3	73	82	3	97	97	3	95	88	3	98	96
DPN (NAD)	M	0	20	27	0	22	34	0	24	25	2	58	66
Duodenum	O	2	73	72	0	63	63	0	63	63	0	56	50
Ecosystems	W	3	24	28	1	31	50	3	66	75	2	36	43
Effects of Alcohol, Narcotics, and Tobacco on Humans	I	3	68	63	0	51	44	0	46	42	0	39	47

Embryonic induction	O	0	50%	43%	3	70%	84%	0	30%	50%	3	63%	54%
Endoplasmic reticulum	Ce	1	35	54	2	74	97	0	34	38	2	77	84
Experimental control	—	2	64	76	3	85	94	0	68	79	3	77	86
Fascia	O	0	14	9	0	10	6	0	8	13	0	7	8
Fermentation	M	3	87	88	3	97	100	2	93	96	3	87	96
Food webs or chains	Co	2	66	70	1	65	63	3	88	92	3	85	87
Gastrulation	O	1	58	57	1	69	78	0	27	50	2	57	68
Gene pool	P	2	27	28	3	76	88	1	34	50	3	43	62
Genetic drift	P	0	27	23	0	37	41	1	42	29	1	40	45
Geotropism	I	2	66	80	2	53	78	1	68	63	2	73	79
Golgi bodies	Ce	1	37	65	0	40	78	0	24	46	3	85	89
Glycolysis	M	0	32	33	2	47	81	0	15	21	0	51	21
Grana	Ce	2	8	24	1	37	72	1	12	29	1	36	46
Hardy-Weinberg principle	P	0	6	10	3	57	72	3	46	38	3	39	41
Heterotroph hypothesis	W	0	27	32	3	85	97	0	17	25	2	56	49
Homeostasis	I	2	24	45	3	66	94	0	19	38	3	74	95
Hydrolysis	M	1	63	64	2	79	97	0	54	46	3	79	82
Hypocotyl	O	3	48	56	0	19	44	0	30	25	2	48	64
IAA (indoleacetic acid)	M	0	8	10	0	15	22	1	14	25	1	21	29
Immunity	O	3	84	87	0	74	78	2	97	83	2	83	83
Imprinting	I	0	28	27	1	28	50	0	39	25	0	36	18
Krebs cycle (citric acid cycle)	M	0	22	20	3	76	94	0	14	17	0	33	22
Lenticel	O	1	50	63	0	6	9	1	41	42	0	24	17
Lepidoptera	I	3	58	57	0	28	16	1	56	46	0	19	24
Light and dark reactions in photosynthesis	M	3	86	87	3	91	100	3	88	96	2	93	93
Meiosis	Ce	3	87	91	3	96	97	3	95	96	3	98	97
Menstrual cycle	I	2	48	51	2	79	94	0	51	46	2	65	87
Meristem	O	2	20	30	1	47	78	2	37	58	0	18	21
Mitochondria	Ce	3	68	87	3	93	100	3	71	92	3	100	96
Mitosis	Ce	3	90	91	3	97	100	3	100	96	3	100	93
Myosin	O	0	29	26	0	35	53	0	27	33	3	61	50
Natural selection	P	3	68	74	3	88	100	3	88	67	3	95	92
Neurospora	I	3	23	23	3	51	69	2	34	42	3	49	50
Niche	Co	1	22	25	1	22	44	0	75	75	0	19	20
Nucleotide	M	3	35	50	3	75	100	2	51	63	3	77	82
Ornithine cycle	M	2	4	6	3	29	69	0	2	8	2	38	49
Parenchyma	O	2	34	38	0	16	25	0	25	4	0	15	14
Peck order	Co	0	9	6	0	49	47	2	34	29	0	11	7
Peptide bond	M	0	30	41	2	90	97	0	37	46	0	52	53
pH	M	0	51	42	3	99	88	3	59	58	2	81	92
Photoperiodism	I	0	19	33	1	38	66	2	12	38	0	20	22

APPENDIX B — continued

Topic	Level	Non-BSCS Rating	Non-BSCS Per Cent Srs.	Non-BSCS Per Cent Jrs.	BSCS Blue Rating	BSCS Blue Per Cent Srs.	BSCS Blue Per Cent Jrs.	BSCS Green Rating	BSCS Green Per Cent Srs.	BSCS Green Per Cent Jrs.	BSCS Yellow Rating	BSCS Yellow Per Cent Srs.	BSCS Yellow Per Cent Jrs.
Pinocytosis	Ce	1	9%	19%	0	15%	9%	0	3%	8%	1	58%	76%
Pleistocene	W	1	22	30	0	18	9	1	63	58	2	35	26
Predators	Co	3	67	72	1	62	72	3	92	92	0	67	67
Protoplasm	Ce	3	93	91	0	97	97	3	100	92	0	95	88
Prophase	Ce	3	68	75	0	65	72	0	69	63	0	60	70
Protista	I	2	22	40	3	40	59	3	73	75	1	52	54
Psilopsida	P	0	13	20	0	7	9	2	15	38	0	20	12
Pteridophyta	P	0	46	50	0	13	21	0	29	29	0	36	22
Ptyalin	M	1	65	78	0	35	66	0	44	33	1	42	59
Pyruvic acid (or pyruvate)	M	1	26	38	3	79	91	0	14	29	3	76	87
Radioactive fallout	W	0	55	53	1	57	50	0	42	54	0	49	36
Retina	O	3	87	84	0	85	78	0	78	58	1	81	74
Ribosomes	Ce	3	59	81	3	94	97	0	75	67	3	95	89
RNA	M	3	66	78	3	96	97	1	83	83	3	92	91
Messenger RNA	M	2	46	64	2	85	94	0	66	67	2	71	75
Semilunar valve	O	1	53	57	0	43	50	0	51	29	0	30	32
Sepals	O	2	78	78	0	51	69	1	73	75	2	85	74
Sex linkage	Ce	3	72	76	3	81	94	2	75	88	3	77	91
Sickle cell anemia	O	0	26	30	0	53	53	3	54	42	2	37	47
Sori	O	2	34	44	0	9	16	0	36	25	0	13	25
Space biology	W	2	27	28	0	7	16	1	14	17	2	19	22
Strip cropping	Co	2	64	59	0	40	16	0	54	42	0	48	21
Thiamin	M	1	75	82	0	66	72	0	42	50	1	71	68
Tobacco moasaic virus	M	1	21	33	1	60	75	0	29	38	3	76	88
TPN (NADP)	M	1	14	33	0	26	53	3	27	50	1	46	74
Tracheophyta	P	2	40	54	1	38	41	3	61	71	0	32	39
Uracil	M	2	15	27	2	68	72	0	8	25	1	27	30
Urea	O	2	73	80	2	71	91	1	63	63	3	85	88
Uric acid	O	1	65	64	2	74	91	1	59	58	2	83	76
Watson-Crick model	M	2	15	30	3	76	94	1	24	29	3	43	43

Note: Level: M = Molecular
Ce = Cellular
O = Organ & Tissue
I = Individual Organism
P = Population
Co = Community
W = World Biome

Rating: 0 = No emphasis
1 = Mentioned
2 = Paragraph or two
3 = Emphasized

APPENDIX C

Percentage of Students Who Reported Experience with Selected Laboratory Activities for Students Classified by First-Year Biology Curriculum and Educational Level

(Based on students who reported taking only a first-year course in biology)

	Non-BSCS					BSCS Blue					BSCS Green					BSCS Yellow				
	P		D			P		D			P		D			P		D		
Laboratory Activity	Srs.	Jrs.	Srs.	Jrs.	M	Srs.	Jrs.	Srs.	Jrs.	M	Srs.	Jrs.	Srs.	Jrs.	M	Srs.	Jrs.	Srs.	Jrs.	M
Dissection of																				
Cat	2%	2%	6%	6%	0	3%	..	9%	6%	0	..	..	8%	7%	0	..	..	7%	7%	0
Crayfish or lobster	60	61	6	4	+	15	6%	6	18	0	39%	18%	17	12	0	32%	47%	14	2	+
Fetal pig	7	10	7	7	+	6	6	12	6	0	14	..	..	12	0	5	28	5	14	0
Fish	48	41	7	7	+	9	6	9	18	0	39	18	..	29	0	29	31	5	7	0
Flower	38	41	13	11	+	40	53	13	6	+	56	53	10	12	+	36	38	17	9	+
Frog	81	84	4	4	+	50	47	15	6	+	97	65	3	6	+	69	78	7	2	+
Fruit	22	23	10	8	+	25	18	9	..	0	30	12	..	6	0	25	14	15	10	0
Moss	12	14	7	6	+	19	12	6	..	0	22	24	3	6	0	12	26	14	3	+
Roundworm (ascaris)	26	20	7	5	+	25	18	9	..	0	25	12	..	..	0	40	30	8	3	+
Earthworm	71	74	4	4	+	32	29	9	..	0	68	41	3	12	0	62	74	7	2	+
Insect	49	49	5	3	+	31	29	6	..	0	51	18	10	12	0	35	38	13	3	0
Pine cone	6	5	9	9	0	..	..	3	6	0	10	24	10	12	0	15	7	13	5	+
Rat or mouse	3	4	4	2	0	3	6	9	6	0	10	..	14	6	0	4	2	1	3	0
Seed	31	42	14	8	+	41	35	3	6	0	34	41	10	6	0	25	50	12	2	0
Experiment on																				
Active transport across a cell membrane	14	17	15	16	0	53	65	12	12	+	29	41	15	6	0	46	43	4	7	0
Rate of multiplication of yeast cells	12	19	18	16	0	38	53	15	12	0	54	59	20	..	+	38	21	11	16	0
Culture and transfer of bacteria	29	30	27	23	+	54	59	13	18	+	63	65	12	16	+	65	45	12	18	+
Development of frog embryos	5	3	14	7	+	6	..	13	18	0	3	18	15	6	+	6	10	14	14	+
Development of chick embryos	6	5	16	15	+	44	41	16	12	+	12	35	17	12	+	17	14	18	30	+
Diffusion	26	31	30	28	+	50	59	13	18	+	54	65	27	6	+	57	60	14	10	+

APPENDIX C—continued

Laboratory Activity	Non-BSCS P Srs.	Non-BSCS P Jrs.	Non-BSCS D Srs.	Non-BSCS D Jrs.	Non-BSCS M	BSCS Blue P Srs.	BSCS Blue P Jrs.	BSCS Blue D Srs.	BSCS Blue D Jrs.	BSCS Blue M	BSCS Green P Srs.	BSCS Green P Jrs.	BSCS Green D Srs.	BSCS Green D Jrs.	BSCS Green M	BSCS Yellow P Srs.	BSCS Yellow P Jrs.	BSCS Yellow D Srs.	BSCS Yellow D Jrs.	BSCS Yellow M
Spontaneous generation	8%	10%	14%	14%	0	32%	24%	13%	12%	+	20%	47%	19%	6%	+	40%	21%	23%	12%	+
Genetic study with Drosophila (fruit fly)	7	9	13	10	+	41	59	15	18	+	19	35	17	6	+	27	22	20	28	+
Germination of seeds	30	35	20	18	+	37	59	13	12	+	56	65	15	6	+	26	57	17	19	+
Observation of cells in onion skin	69	74	7	4	+	57	53	6	6	0	64	76	3	..	+	85	86	..	2	+
Osmosis	32	37	28	24	+	56	53	10	12	+	39	47	29	18	+	54	34	14	16	0
Paper chromatography	7	11	4	6	0	50	53	9	12	+	19	32	8	..	+	27	28	1	2	+
Phototropism in plants	18	19	25	30	+	38	47	15	24	+	39	12	25	12	+	18	28	14	26	+
Quadrat study	2	2	1	2	0	9	6	3	..	0	22	29	7	..	0	1	..	..	..	0
Regeneration of planaria	15	16	17	16	+	57	65	13	12	+	24	29	15	12	+	25	14	17	22	+
Respiration using a volumeter	5	5	6	5	+	15	29	..	6	+	7	12	8	6	0	4	7	7	2	0
Test for sugar content of a substance	36	39	18	15	+	50	71	1	..	+	46	65	10	..	+	69	69	8	7	+
Test for starch in leaves	34	30	18	15	+	63	65	4	6	+	44	47	17	..	+	62	53	7	14	+
Transpiration using a potometer	1	2	3	1	0	9	..	6	..	+	..	6	3	6	+	2	3	1	2	0
Typing of blood	29	32	10	13	0	66	76	4	6	+	42	12	7	24	+	38	45	8	5	0
Photosynthesis	26	25	25	21	+	44	59	21	6	+	46	29	29	12	+	52	43	12	16	+
Plant growth hormones	4	3	8	9	0	15	18	10	12	+	22	12	10	6	+	7	7	12	12	+
Digestion	13	19	18	13	0	21	53	15	..	+	27	24	14	..	+	25	38	12	5	+

.. Indicates less than 1.0%

Note: P = Participates
D = Demonstrated
M = Manual
+ = in Lab Manual
0 = Not in Lab Manual

APPENDIX D

Percentages of Students Who Reported Class Discussion of Selected Scientists for Juniors and Seniors Classified by First-Year Biology Curriculum (Based on students who reported taking only a first-year course in biology)

	Non-BSCS			BSCS Blue			BSCS Green			BSCS Yellow		
Scientist	Srs.	Jrs.	Text	Srs.	Jrs.	Text	Srs.	Jrs.	Text	Srs.	Jrs.	Text
Claude Bernard	12%	7%	0	18%	38%	+	..	3%	0	8%	5%	0
Luther Burbank	62	58	+	37	38	0	51%	23	0	62	29	0
Melvin Calvin	29	21	0	53	58	+	37	10	0	32	25	+
Francis Crick	16	29	+	76	94	+	22	33	+	43	41	+
J. B. S. Haldane	3	4	0	25	38	+	3	3	0	2	..	0
William Harvey	64	65	+	74	94	+	47	40	0	73	74	+
Jean-Baptiste van Helmont	17	25	+	62	82	+	34	30	+	61	63	+
Anton van Leeuwenhoek	83	81	+	88	94	+	88	73	+	98	89	+
Joshua Lederberg	11	10	0	40	52	+	8	13	0	38	37	+
Carolus Linnaeus	66	65	+	72	76	+	85	70	+	75	72	+
Thomas Malthus	18	17	0	59	73	+	39	50	+	35	33	+
Gregor Mendel	82	82	+	91	91	+	88	77	+	86	86	+
Thomas Hunt Morgan	29	41	+	37	50	+	37	30	+	36	57	+
H.J. Muller	23	34	+	47	68	+	19	27	+	35	46	+
Severo Ochoa	2	3	0	25	53	+	..	3	0	12	7	+
Francesco Redi	39	56	+	79	85	+	44	33	0	80	83	+
Lazzaro Spallanzani	18	28	+	74	91	+	25	30	0	75	82	+

.. Indicates less than 1.0%

Note: 0 = Not in text
+ = In text

APPENDIX E

Percentage Distributions of Responses to Questions about Time Spent in First-Year Biology Classes for Students Classified by Educational Level at Time of Survey, First-Year Biology Curriculum, and Type of Support and Geographical Location of Secondary School

(Based on the total sample)

Distributions for Students Classified as Seniors

Item	Curriculum				Type of School			Location of School			
	Non-BSCS	BSCS Blue	BSCS Green	BSCS Yellow	Public	Roman Cath.	Inde-pendent	North-east	South	Mid-west	West
Average time per week spent in laboratory work											
None	5%	3%	5%	1%	5%	2%	7%	5%	6%	4%	4%
30 minutes or less	18	12	11	9	20	8	12	15	19	25	17
About 45 minutes	22	21	8	15	21	26	15	29	15	13	12
About 1 hour	17	16	12	19	17	18	14	15	20	21	20
About 1 1/2 hours	19	16	33	34	18	29	18	23	16	14	16
About 2 hours	12	16	20	16	12	10	22	9	15	14	21
More than 2 hours	7	15	12	5	7	7	12	4	9	10	10
Average number of class periods per week											
Three or fewer	1	4	1	3	1	1	..	..	6	1	2
Four	4	6	..	4	4	3	19	7	3	2	..
Five	67	67	83	54	72	46	44	54	85	75	90
Six	14	10	8	23	10	34	21	23	4	4	4
Seven	11	9	5	13	10	12	12	13	1	14	2
Eight	1	..	3	..	1	2	1	..	..	2	..
Nine	..	..	..	..	..	..	..	..	..	..	..
Ten	..	4	..	..	..	2	3	..	..	1	1
Eleven or more	..	..	..	2	..	..	..	..	..	..	1
Average length of single class period											
Less than 40 minutes	1	..	2	5	1	1	..	2	..	..	1
40 to 49 minutes	51	43	29	50	47	73	60	78	11	26	21
50 to 59 minutes	42	51	57	37	46	22	34	17	79	67	71
60 minutes or more	5	6	12	8	5	4	5	3	9	7	7

APPENDIX E—continued

Distributions for Students Classified as Juniors

Item	Curriculum				Type of School			Location of School			
	Non-BSCS	BSCS Blue	BSCS Green	BSCS Yellow	Public	Roman Cath.	Inde-pendent	North-east	South	Mid-west	West
Average time per week spent in laboratory work											
None	2%	..	4%	1%	3%	1%	..	2%	2%	4%	4%
30 minutes or less	13	10%	12	9	12	9	4%	10	12	11	9
About 45 minutes	24	13	8	20	24	29	12	27	2	4	13
About 1 hour	14	13	16	15	14	10	10	11	16	22	9
About 1 1/2 hours	26	26	36	28	19	36	35	26	14	19	26
About 2 hours	11	15	12	13	11	3	20	9	28	19	17
More than 2 hours	10	23	12	14	8	7	17	7	19	19	17
Average number of class periods per week											
Three or fewer	2	..	..	..	2	..	..	..	..	7	..
Four	3	5	..	2	3	..	2	2	2	..	4
Five	48	44	69	35	51	35	15	40	56	56	57
Six	31	23	23	32	23	52	38	35	12	..	17
Seven	13	23	4	25	10	9	33	13	23	15	13
Eight	2	5	4	5	3	..	2	2	2	11	..
Nine	..	..	..	..	..	..	1	..	..	..	..
Ten	..	..	..	..	1	..	..	..	..	..	..
Eleven or more	..	..	..	..	1	1	..	..	..	4	..
Average length of single class period											
Less than 40 minutes	2	..	8	3	2	2	..	2	..	..	..
40 to 49 minutes	68	66	48	73	57	74	82	71	37	30	30
50 to 59 minutes	26	32	44	19	26	14	12	17	51	37	37
60 minutes or more	5	3	..	5	4	6	..	2	5	22	22

.. Indicates less than 1.0%

APPENDIX F

Percentages of Juniors and Seniors Who Reported Primary or Secondary Use of Selected Textbooks in the First Course in Biology

(Based on all students)

Author	Title	Seniors		Juniors	
		Primary Text	Secondary Text	Primary Text	Secondary Text
Alexander	General Biology	2%	1%	2%	1%
Biological Sciences Curriculum Study (BSCS)	Blue Version (Molecules to Man)	5	2	7	3
Biological Sciences Curriculum Study (BSCS)	Green Version (High School Biology)	4	2	4	3
Biological Sciences Curriculum Study (BSCS)	Yellow Version (Biological Sciences, An Inquiry Into Life)	5	2	14	4
Curtis and Urban	Biology: The Living World	2	2	..	2
Dodge	Elements of Biology	2	..	1	2
Fitzpatrick, Bain, and Teter	Living Things	..	2	..	.1
Johnson, Laubengayer, and Delaney	General Biology	..	1	..	..
Kroeber, Wolff, and Weaver	Biology	2	1	2	2
Marsland	Principles of Modern Biology	..	..	..	1
Otto and Towle	Modern Biology	43	7	36	10
Simpson, Pittendrigh, and Tiffany	Life: An Introduction to Biology	..	1	..	1
Smith	Exploring Biology: Science of Living Things	5	2	6	2
Weisz	Elements of Biology	..	1	..	2
Weisz and Fitzpatrick	Science of Biology	..	1	1	2
Wheat and Fitzpatrick	Biology	..	..	..	1
Texts not specifically listed		8	4	6	4

.. Indicates less than 1.0%

Note: Although the following texts were listed in the questionnaire, they were used as primary and as secondary texts by less than 1.0% of the juniors and by less than 1.0% of the seniors in the sample: Baker, Mills, and Tanczos, New Dynamic Biology; Biological Sciences Curriculum Study (BSCS), Biological Science: Interaction of Experiments & Ideas; Brown, Biology; Celeste, Biology for Catholic High School; Eisman and Tanzer, Biology and Human Progress; Fenton and Kambly, Basic Biology; Goodnight, Goodnight, and Armacost, Biology: An Introduction to Science of Life; Gregory and Goldman, Biological Science for High School; Hardin, Biology: Its Principles & Implications; Kimball, Biology; Lauby, Silvan, and Mark, Biology; Milne and Milne, Biotic World and Man; Moment, General Biology; Nason, Textbook of Modern Biology; Smith and Lisonbee, Your Biology; Taylor and Weber, General Biology; Trump and Fagel, Design For Life; Vance and Miller, Biology for You; Villee, Biology.